# SOME CONSIDERATIONS IN THE OPERATIVE TREATMENT OF FRACTURE OF THE PATELLA, WITH SPECIAL REFERENCE TO SUTURE MATERIAL AND THE USE OF SALT SOLUTION.

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THE operative treatment of fracture of the patella, either from choice, in simple cases, or from necessity in those which are compound, is perhaps a somewhat trite subject. The popularity of different methods rises and falls, and we are still apparently as far as ever from a set of rules acceptable to all surgeons. There are, however, some points connected with the strictly operative treatment which I think it will not be uninteresting to discuss in the light of some clinical experiences. The form of operative treatment which I wish to discuss is that applied to cases within from four to seven or eight days of the occurrence of the injury, and that which involves the more radical operative measures, not considering the methods employing hooks or subcutaneous suture, which can hardly be called operative methods in the sense in which I am using the term. Perhaps it will be as well to quote some cases first, and discuss their points of interest later. The cases which I am about to describe are all cases operated upon in Roosevelt Hospital, New York, and they represent *all* the cases of fracture of the patella subjected to the operative form of treatment from November, 1892, to November, 1893. They are not cases selected simply for the good result. Every case of the class under discussion has been described,—that is, all cases of recent fracture of the patella, either simple and having certain characteristics which I shall mention, or cases in which the fracture was compound. During the year mentioned only one case of recent fracture of the patella besides these which I am about to describe was subjected to ward treatment in Roosevelt Hospital. That case was treated with straps, and the result was moderately good.

CASE I.—Boy, aged fifteen years. Injury received by falling from the roof of a house four stories to the ground. Patient sustained a compound comminuted fracture of the right patella, and in addition a simple fracture of the right femur and of the left tibia and fibula. I operated the same evening (in August, 1893), and found that the patella had been shattered into six or eight irregular fragments, some of which were entirely free, while others were held together by ragged bands of aponeurosis. The *ligamentum patellæ* was torn from the lower part of the bone, taking a piece with it. The joint was full of blood-clot and fluid blood. I made the incision free and transverse; several of the loose fragments of bone were removed, all the fluid and coagulated blood cleared away, and the joint washed out with a six-tenths of one per cent. salt solution. The larger fragments were drilled and sutured with ordinary catgut, and the end of the *ligamentum patellæ* sutured with the same material to the reconstructed patella. The subsequent treatment was dressing on the third day to remove the rubber-tissue drains, and then fixation for about three weeks, then a change of dressing and the beginning of a small amount of lateral movement of the patella to guard against the formation of adhesions. At the end of six weeks the patella was freely movable laterally, and movements of flexion were begun. Improvement was uninterrupted, and in twelve weeks the boy was walking. Eighteen months after the injury the boy has an absolutely perfect knee-joint, and the evidence of previous fracture in his patella appreciable by palpation are practically nothing. There is absolutely no limitation of motion in the joint, and the movements of the patella are perfectly smooth.

CASE II.—H. D., male, aged twenty-five years; admitted, five days after injury, on December 16, 1892. Operation on eighth day from day of injury by Dr. McBurney. Fracture occurred in the common way by violent muscular action. When patient was admitted he had a right knee-joint very much distended with blood, which, of course, at that date must have been firmly coagulated; the whole region of the joint was much swollen and ecchymotic, and the exact size and shape of the fragments could not be made out by palpation.

The case was considered one not only eminently suitable for treatment by operation, but one actually requiring such treatment if a good result was to be obtained. The operation was done through the usual transverse incision, and the joint was found filled with large firm clot separating the fragments and filling the space between them. The lower fragment was much smaller than is observed in the average case, and its fractured surface faced directly forward, making apposition with the other fragment by any means except operative clearly impossible. The blood-clot was cleared away, and the joint carefully washed clean with the usual hot salt solution. The fragments were drilled and sutured with catgut, and the capsule of the joint sutured with the same material where it had been opened at the sides by the incision which had been made so as to give access to all parts of the joint. Folded rubber-tissue for drainage not going into the joint. Characteristic aseptic course.

January 12, wound is healed, and heavy dressing is changed for a lighter one. January 13, passive motion is begun *laterally* only. February 6, patient walks with a short splint. Flexion is begun and efforts repeated daily. February 26, patella freely movable, especially in lateral directions; union close and good. March 1, all splints have been dispensed with. March 13, the patient is discharged cured, with voluntary flexion to sixty degrees and solid union in the bone.

CASE III.—F. H., male, aged twenty-eight years. Admitted December 24, 1892, and operated upon on seventh day from that time by Dr. McBurney. Usual transverse incision. The condition was found to be typical of fracture of the patella from muscular action. The lower fragment was bevelled and the joint entirely filled with firm clot. This was cleared away, and the joint washed out in the usual manner with sterile salt solution used hot. The fragments of patella were drawn together with catgut in the usual way, drill-holes first having been made in them for the passage of the sutures. The incision in the capsule of the joint at each side of the patella was also carefully closed by suture. The superficial portions of the wound were drained with folded rubber tissue, which was removed at the end of a few days. January 15, wound entirely healed. January 31, the patella is found to be movable on the condyles, and union between the fragments so far good.

Moderate massage has been employed for the past two weeks. February 6, good lateral motion is possible in the case of the patella, and movements of flexion are begun and employed daily. March 4, voluntary flexion to a right angle is now possible, and all splints are dispensed with. The patient was discharged cured a few days from this last date, with voluntary flexion to a right angle, smooth joint action, bony union, and no limp.

CASE IV.—J. H., male, aged thirty-two years. Patient admitted January 13, 1893, and operation done by Dr. McBurney the next day. This fracture was caused by direct violence, and in addition to the fracture there was a transverse wound over the patella one inch long. The fracture of the patella was also transverse, but not directly under the skin wound, with the leg extended. The line of fracture was straight and clean. There was no bevelling and no comminution. The incision was the usual transverse one. The joint was found full of blood-clot, and there was a good deal of subcutaneous extravasation all over the front of the joint. The fragments of patella were not very widely separated, but what space there was between them was full of blood-clot. The joint was cleared of clot and washed out thoroughly with hot-salt solution, as in the other cases, and the bony fragments were drilled and sutured with catgut in the usual way. In closing the superficial wound, folded rubber-tissue drains were used; and at each corner the folded tissue was placed so that its end lay in the joint. January 21, drains removed and wound found normal. At the end of the third week passive motion and massage were begun, but flexion was avoided at this early date. The patella, however, was moved moderately and increasingly from side to side. At the end of six weeks flexion was begun and slowly increased in extent. March 1, flexion is possible to sixty degrees, with smooth joint action. March 14, solid union between fragments has occurred, and is, without doubt, bony. Action of joint is normal, except that there is moderate limitation of flexion, which is slowly disappearing. Patient is discharged with a normal gait.

Of course, these cases which I have just described can have no *statistical* value for obvious reasons. I think, however, that they do possess an *illustrative* value, in showing the results of a certain line of treatment carried out in all four cases. As will be noticed, two of the cases occurred in the common way from muscular action, and in two the injury was sustained by direct violence. Before discussing the subject any further, I should like to mention briefly two cases closely allied to those under discussion, operated upon, one by Dr. McBurney and one by Dr. Hartley, through the courtesy of which gentlemen I am able to quote them. I refer to two cases of rupture of the quadriceps extensor tendon.

CASE I.—T. K., male, aged fifty-three years. Admitted November 30, 1892, and operated upon on the fifth day from date of injury by Dr. McBurney. The injury was caused by a heavy body striking the tense tendon, with the knee in a position of moderate flexion. The tendon was found completely divided and the joint full of blood. The treatment was exactly similar to that in the cases of fracture, and the course uninterrupted to recovery.

January 8, passive movement begun with lateral movement of the patella, and flexion to a very slight degree. February 1, the joint is almost absolutely normal. February 5, the patient is discharged with an absolutely perfect joint, which is entirely under his control. This patient is further remarkable for the fact that eighteen months after his injury he was unfortunate enough, while doing the same kind of work, to sustain an exactly similar injury to the tendon of the other leg. Exactly the same treatment was resorted to with the same excellent final result.

CASE II.—T. P., male, aged forty-four years. Admitted June 9, 1893, and operated upon next day by Dr. Hartley. The right quadriceps tendon was ruptured by a severe blow while the tendon was tense. The joint presented the usual amount of distention with blood, but the divided ends of the tendon were somewhat more ragged than in the other case. The joint and tendon were treated as in the previous case, and the subsequent course was the same. I might add that the sutures at the patellar end of the torn tendon in each case were passed on a drill and included the edge of the bone. The ultimate result in this case was excellent and the patient was lost sight of in a few months.

I have quoted these additional cases to further illustrate certain facts which I consider of importance in connection with the subject of fracture of the patella, believing that, from the similarity of the conditions after the injuries in question, such cases are sufficiently *apropos*.

Suppose, now, that we have a case of fracture of the patella of the ordinary kind, we find ourselves called upon to decide, first, whether, in this individual case, the operative form of treatment will give a better result than one of the other forms of treatment in which apparatus or splints are used; second, when the operation shall be done; and third, the plan of operation with its details.

If we were absolutely infallible in our operative technique, and if the undergoing of an operation did not involve a certain indeterminate amount of risk to the patient, probably all cases of fracture of the patella would end in better results if treated by operation with accurate approximation of the fragments than if treated by any other means.

But, unfortunately, such a happy state of affairs does not exist, and we are compelled to select cases, each of us, according to his judgment and experience. Perhaps the first condition which strikes one who has seen many cases of fracture of the patella is the varying amount of subcutaneous and intra-articular effusion of blood during the first few hours after the injury, this, of course, depending largely on the amount of laceration of soft parts and the size and distribution of the torn vessels. This extravasation of blood is, of course, of great importance in deciding whether to recommend operative treatment or not. For if, at the end of say twenty-four hours, the joint is full of such blood, and the tissues in its neighborhood are infiltrated and ecchymotic, making accurate palpation or diagnosis impossible, a much better result will be got if the joint is opened, cleared of its blood-clot, and the fragments accurately opposed,—bony surface to bony surface. The degree of such conditions necessary to be present to impel a surgeon to operate will, of course, depend on his experience and opportunities for carrying out aseptic technique. There are, of course, cases of fracture of the patella in which the conditions are so simple and the opportunities for accurate palpation so good, that even the most enthusiastic operator would probably not advise treatment by operation, but these are not *average* cases, and just as distinctly demand non-interference as cases like those of the first class require treatment by operation, if we wish to secure an approximately perfect result. It has been urged as an argument against early operation that the tissues in and around a knee-joint, in cases of fracture of the patella, have their power of resisting septic invasion lowered by the traumatism to which they have been subjected, and the local circulatory disturbances caused by the extravasation of blood with the changes in this blood consequent upon its alteration and absorption. The statement is, no doubt, true from a pathological point of view, but if we are really aseptic we need not fear this condition; if we cannot be aseptic we should not open the knee-joint under any circumstances. There are no degrees of asepsis. A good deal also depends on a patient's willingness to undergo an operation, and whether he is intelligent enough to understand the situation when we place it before him in its different phases. However, I leave the question as to what cases demand operation with only the general statement that they are those with a considerable amount of effusion of blood into the joint or with very marked bevelling of the fragments, or both, among cases of simple fracture, and all cases of compound fracture.

The choice of a suture material in the cases under discussion is a subject about which there has been a good deal of controversy, with apparently very little definite result as far as getting any general agreement as to what is most suitable from every point of view. The possible materials are practically three,—catgut, silk, and silver wire. No one probably would deny the great desirability of an absorbable suture, provided there could be a reasonable guarantee of its sterility, strength, and ability to last long enough in the tissues to permit a certain amount of union between the opposed surfaces.

Silk and silver wire can without question be easily made sterile, and each is very strong. However, the question of the comparative *ease* or *difficulty* of sterilization of suture material is one which, in the present state of surgical knowledge, we should not allow to trouble us. If a suture material can be sterilized, and is useful, we must sterilize it. Because it is more difficult in the case of catgut than in that of silk to attain perfect safety in sterilization, it is not necessary to give up catgut, if catgut is otherwise a better suture material than silk. We should see to it that our catgut *is* sterile. Many good results have unquestionably been obtained by the use of silk or wire, but most surgeons can probably recall cases returning after weeks or months with a small sinus leading to a suture in the patella, which refuses to heal, and requires removal of the offending material before healing can be obtained. This is especially apt to be the case after the use of wire. Furthermore, there may be a carious process started in the neighborhood of the suture which will require one or more scraping operations before healing occurs. The possibility of such occurrences in the use of non-absorbable materials indicates to me a wrong *principle* in carrying out the operation, for the defective results do not depend on an error of judgment or technique, but upon qualities inherent in the materials we use,—*i.e.*, their non-absorbability and consequent power to cause irritation. The idea that catgut is not strong enough, and will not last a sufficient time in the tissues, is, I believe, a mistaken one. The fact that we are dealing with this bone, the patella, and not with a soft tissue, need not, I think, make any difference in our choice of suture material. In ordinary cases of tendon suture we use catgut, and the proportionate strain on the suture is no greater in the large quadriceps tendon than in the small one where we must use smaller material. Very few surgeons would put a wire suture into a ruptured quadriceps tendon, very many would suture a broken patella with that material, yet the amount of tension which the sutures will be compelled to sustain is the same, and catgut in one place should be as safe as in the other, for the character of the newly-formed or forming tissue between the divided ends of such a tendon and between the bony fragments is certainly, as far as its tensile strength is concerned, the same during the first four or five days. If catgut sutures will not hold a fractured patella long enough to prevent separation of the fragments, they should not be trusted to hold a divided quadriceps tendon, something which I have seen such sutures do a number of times perfectly. The use of silk is open to the same objections as the use of wire, but in a lesser degree. When we have an unfortunate result with the use of catgut, the trouble is usually an error of technique, and an avoidable error. Admitting that catgut prepared in the ordinary way is absorbed in about four days, or at least so softened as to retain little strength, a carefully-applied dressing of sufficient rigidity, and the usual care in preventing muscular exertion, especially during subsequent dressings, may relieve us of the fear that the fragments will be pulled apart. The danger from an involuntary spasmodic muscular contraction is certain to disappear at the end of forty-eight hours or so, and after that the patient does not run the risk of himself tearing the fragments apart under a good dressing, if he is conscious and sensible. In all cases of suture of the patella after fracture, rupture of the quadriceps tendon, and division of other tendons by any means, which have occurred in Roosevelt Hospital in recent years, catgut sutures have been used, and their use has not been regretted on account of too early giving way of the material.

Let us now turn from suture material and consider briefly the subject of the employment of different solutions in the knee-joint during operations. If from any cause the vitality of the endothelial cells of the synovial membrane or its lymphatic vessels is interfered with, their power of performing their proper function is lost, and they may be killed and desquamate. When this process of desquamation, whether due to chemical irritation or inflammatory action, occurs, we see in the synovial membrane involved a process analogous to certain forms of peritonitis. If the irritation is slight, the cells are reformed and there is *restitutio ad integrum*; if the irritation is severe, we have a process similar to that seen in peritonitis with the formation of fibrous adhesions, consisting, of course, of connective tissue. It is these adhesions which are responsible for many cases of complete or partial "fibrous" ankylosis. When a fracture of the patella occurs, we have a joint at once more or less filled with blood, which must, in an aseptic state of affairs, undergo absorption or organization into connective tissue, or a combination of the two processes.

For the process of absorption to take place promptly and thoroughly, we must have normal functionating endothelium and lymphatic vessels, since an important part of the function of such endothelium and the lymphatic vessels of which it is an important part is the regulation of the amount of fluid in a joint, the removal of an excess or the supply of a deficiency. Now such a joint is opened by operation and is treated in one of several ways after being cleared of its blood-clots: it is washed out with some warm antiseptic solution; it is treated in the same way with distilled water or sterile .6-per-cent. salt solution, or an attempt is made to do a dry aseptic operation. Let us consider briefly these methods. When we treat the living animal cell, for example, the red or white blood-cells, with certain chemical substances or *distilled water*, and examine them with the microscope, certain well-known changes are seen which indicate that life and function for the protoplasm of these cells are impossible in the presence of such substances, among which, as indicated, is distilled water. Now what is true in this regard of the blood-cells is true of other animal cells, and consequently of those delicate endothelial plates lining the joints, peritoneum, pleuræ, etc. Therefore, when we subject these cells to a process which lowers their vitality, interferes with their function, or kills them, we *may* open the way for easy bacterial invasion and septic absorption, and *do* diminish the prospects of getting a joint without adhesions. It appears to me that the injurious effects of chemical antiseptics and of distilled water depend largely on two things,—an actual chemical destructive action and a difference in osmotic qualities between the interior of the cells and the surrounding fluid. Doubts might be expressed as to the prime importance of integrity in the endothelial layer, but I think that too much importance cannot be attached to efforts to preserve this layer from all injury and irritation. Of course, the use of the stronger antiseptic solutions in joint operations has long been discountenanced, except in the presence of septic processes, and we need not consider such use now. But the use of any antiseptic solution is a disadvantage in a clean joint, for it, as I have tried to show, injures the endothelium, and so may interfere with the excellence of the result, and, furthermore, its use in a clean joint is a confession of lack of confidence in our asepsis. The use of sterile distilled water is open to the same objections as the use of antiseptics and for the same reasons, though perhaps in a less degree. An aseptic operation done without the introduction of any fluids into the wound is a practical impossibility. We speak of a dry operation, meaning one in which no fluids are intentionally introduced into the wound, and one in which everything used in the operation is sterilized dry. But we cannot sterilize our hands dry, and, moreover, a field of operation exposed for a considerable time to the air, and dried from time to time with sterile gauze or sponges, runs a certain amount of risk from dust which may be present in the air. Furthermore, damp gauze or sponge is more effectual in removing blood than the same materials used dry. When we operate by the salt solution plan, I think we do so under the most favorable circumstances for securing an immediate and remote good result. In sterile .6-per-cent. sodium chloride solution we have a preparation which very nearly approaches the serum of the blood in its chemical and physical properties. It does not injure the animal cell in any way, can be made easily in large quantity, and sterilized by filtering and boiling. If an open joint is washed out with such a solution, the advantages are almost too obvious for comment. Even in the presence of a certain number of bacteria the use of such a bland solution would allow the endothelial cells and the small lymphatic vessels to combat their bad effects much more easily than if an antiseptic irritating solution were used.

In a recent contribution to the subject, Dr. McBurney[1] has shown what excellent results have been accomplished by the use of salt solution in cases of general septic peritonitis, cases in which results have been almost without exception fatal with other forms of treatment. He attaches very great importance to the use of salt solution on account of its non-irritating qualities. In conclusion, I believe that in cases of fracture of the patella treated by operations we will get the best results by using catgut sutures, washing the joint clean with physiological saline solution, and employing early passive movements and massage,—that is after the third week ordinarily. It is needless to emphasize the importance of *asepsis.*

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[1] New York Medical Journal, 1895, Vol. XLVII, No. 13.